# POROUS PAVEMENT PILOT PROJECT

## 17th NJDOT Research Showcase

**Mount Laurel, NJ**

**October 28, 2015**


**Presenters:**

- **Vivek Jha (AID)**
- **Robert Sauber (RWS Consulting, formerly of AID)**


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# POROUS PAVEMENT PILOT PROJECT

**Outline**:

- What is porous pavement?
- Project Details
- Selection criteria
- Literature Review
- Design procedure
- Material selection
- Construability
- Maintenance Plan
- Post Testing FWD results & Comparison
- Design Guide


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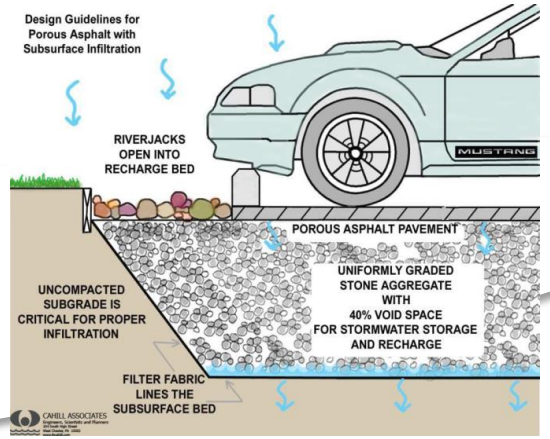
# POROUS PAVEMENT PILOT PROJECT

- What is porous pavement
  - Hot Mix Asphalt without fine aggregate to create a high void content
  - Allows water to drain through the pavement rather than running off
- Advantages
  - Ground water recharge
  - Reduce storm water sewer loads
  - Pollutants filtered from runoff water
- Problems
  - Limited use on high traffic pavements so modified design and materials
  - Requires routine maintenance to remain porous
- Typical Applications
  - Parking Lots, eliminates detention basins
  - Areas where fresh groundwater is being depleted due to development
  - Permitting issues due to increased imperious area

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# POROUS PAVEMENT PILOT PROJECT

- Quick History
  - Developed by Franklin Institute-1972
  - Tested in pilot projects during 1970's
  - 100's of projects built over last ~45 years
  - Parking lot constructed in 1977 in Walden Pond, MA still working great
  - Lower demand for deicing chemicals reported

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# POROUS PAVEMENT PILOT PROJECT

**Project Details**:

- Route 27 Section 3E over Six Mile Run Creek, MP 11.55
- Located in North Brunswick Township, Middlesex County, & Franklin Township, Somerset County
- Primary aspect of the project was bridge replacement with outside shoulder to be reconstructed
- Construction completed this past summer (2015)
- Owner: NJDOT
- Designer: Advanced Infrastructure Design, Inc
- Prime: TRC
- Contractor: Carbro Constructors Corp.
- Resident Engineer: Nanama Awuku
- HMA Producer: Trap Rock & Stavola


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# POROUS PAVEMENT PILOT PROJECT

**Project Selection Criteria**:

- Widening of existing roadway triggered permitting due to increased impervious area
- Percolation testing of existing material revealed subgrade had fair to good drainage properties
  - Percolation Rate: 2.5 – 5 in./hr; NAPA IS-131 states infiltration rate of 0.1 to 10 in./hr works best
- Construability issues were explored and NJDOT required that one travel lane in each direction must be maintained throughout the duration of the project
- Staging plans shifted mainline traffic onto outside shoulder for short duration (~1 month)

# POROUS PAVEMENT PILOT PROJECT

**Literature Review**:

- NAPA Information Series 131: Porous Asphalt Pavement for Storm Water Management
  - Provided general guidelines for design, construction, and maintenance
  - Provided insight into structural design inputs used by government agencies
  - Porous Asphalt: 0.4-0.42; Asphalt Treated Permeable Base (ATPB): 0.3-0.35; Aggregate Base: 0.1-0.14
- Drainage Report prepared by TRC for this project revealed the drainage system was designed for 10-year storm and the proposed improvements did not trigger NJDEP Stormwater management issues
- Various other studies
  - Most studies did not analyze structural design except for one underway at Univ. of California Pavement Research Center. They are developing a ME design procedure.
  - Based on literature reviews we found that other states have been experimenting with porous pavements, Arizona DOT did a project in 1986.
- Talked to experts from this field: Audrey Copeland and Kent Hansen (NAPA), Dr. Li (ITS-Davis, UCPRC), Robert Roseen (UNH Stormwater), George Koerner (GSI)

# POROUS PAVEMENT PILOT PROJECT

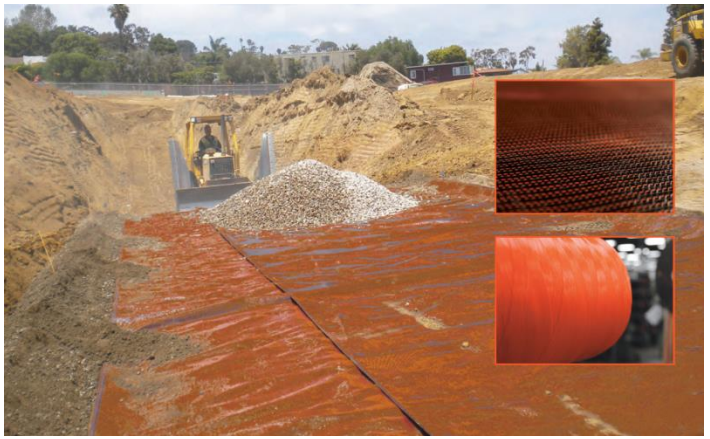
**Design Assumptions**:

- 20-year Design life
- Traffic on shoulder pavement was assumed to be 10% of mainline lane traffic volume
- 2011 ESAL factors were used; 20-year ESAL: 653,000
- Layer Coefficients: MOGFC: 0.40, ATPB: 0.22, Coarse aggregate storage bed: 0.14
- Based on 1993 AASHTO GUIDE for Design of Pavement Structures and NJDOT Companion Manual
  - 2" MOGFC
  - 10" ASDC
  - 1" thick choker course of ¾-inch crushed stone
  - 12" -36" thick washed No. 2 crushed stone storage bed
  - Twill Weave Geotextile was selected for separation, filtration and stabilization

# POROUS PAVEMENT PILOT PROJECT

**Material Selection**:

- Subgrade Preparation
  - Uncompacted soil
- Twill Weave Geotextile (Tencate Mirafi RS380i)
  - Drainage, Separation & Reinforcement
- Crushed Stone Storage Bed (washed to remove fines)
- Asphalt Stabilized Drainage Course, or ATPB
- MOGFC-2 (riding surface)
- No Tack coat



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**Challenges**:

- Roadway Profile +/-3% Grade, cascading steps detail developed
- Limited width work area, don't want equipment on subgrade to avoid compaction
- Traffic to be maintained during construction
- Filled arch bridge being replaced in kind, where does the pavement end?
- Perc tests difficult to perform during 9AM to 3PM daytime lane closure
- Stronger geotextile selected to help compensate for no subgrade compaction
- Depth of storage bed limited to avoid need for trench shoring

**HMA Materials**:

- Trap Rock Industries eliminate the fibers in the HMA by using warm mix technology
- Stavola's ASDC mixture contained fibers to help reduce drain down
- All Open Graded Mixtures specified polymer modified binder to increase strength and durability

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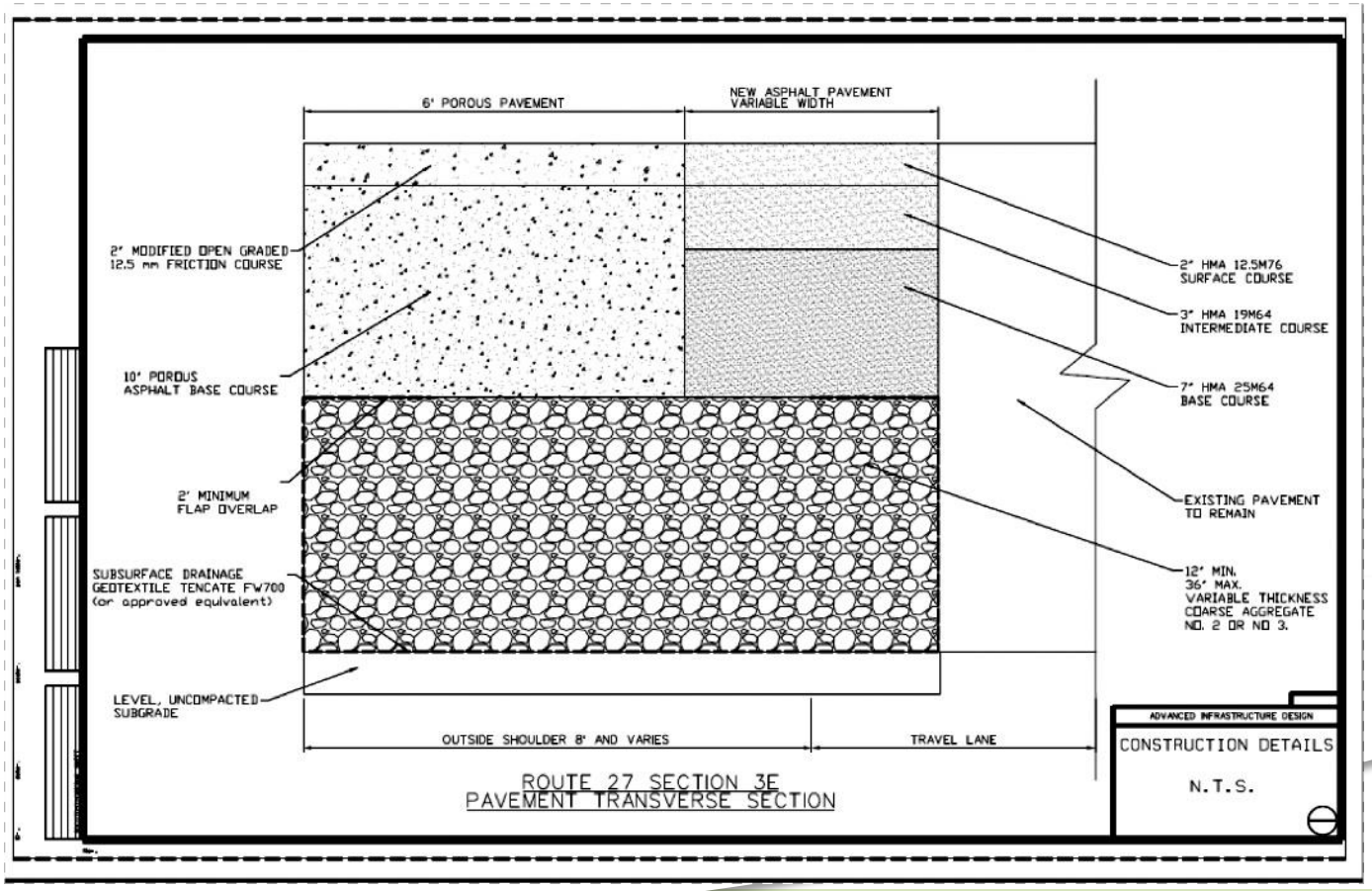
# POROUS PAVEMENT PILOT PROJECT

## Initial Designed Transverse Sections

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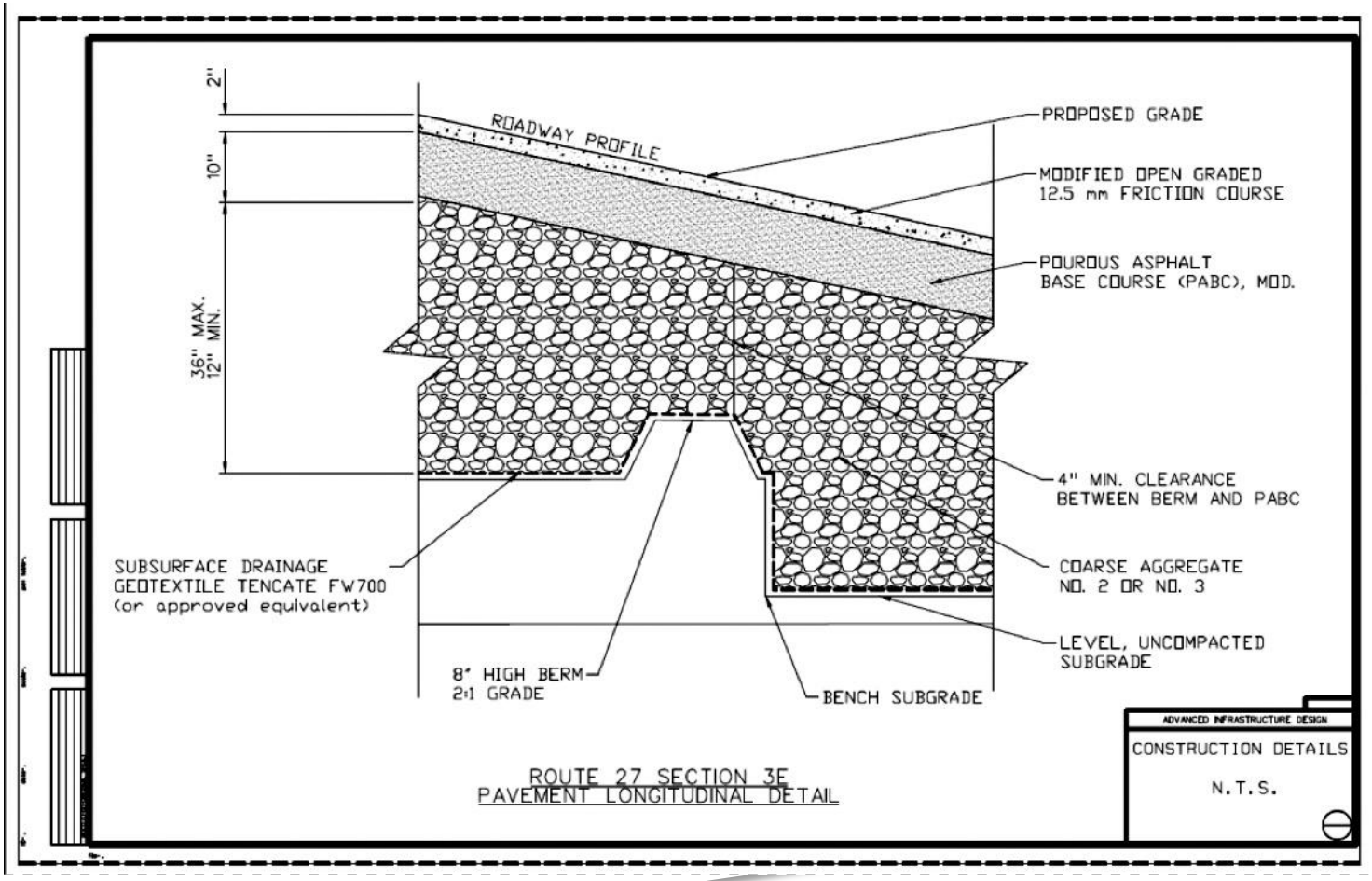
# POROUS PAVEMENT PILOT PROJECT

## Initial Designed Longitudinal Sections

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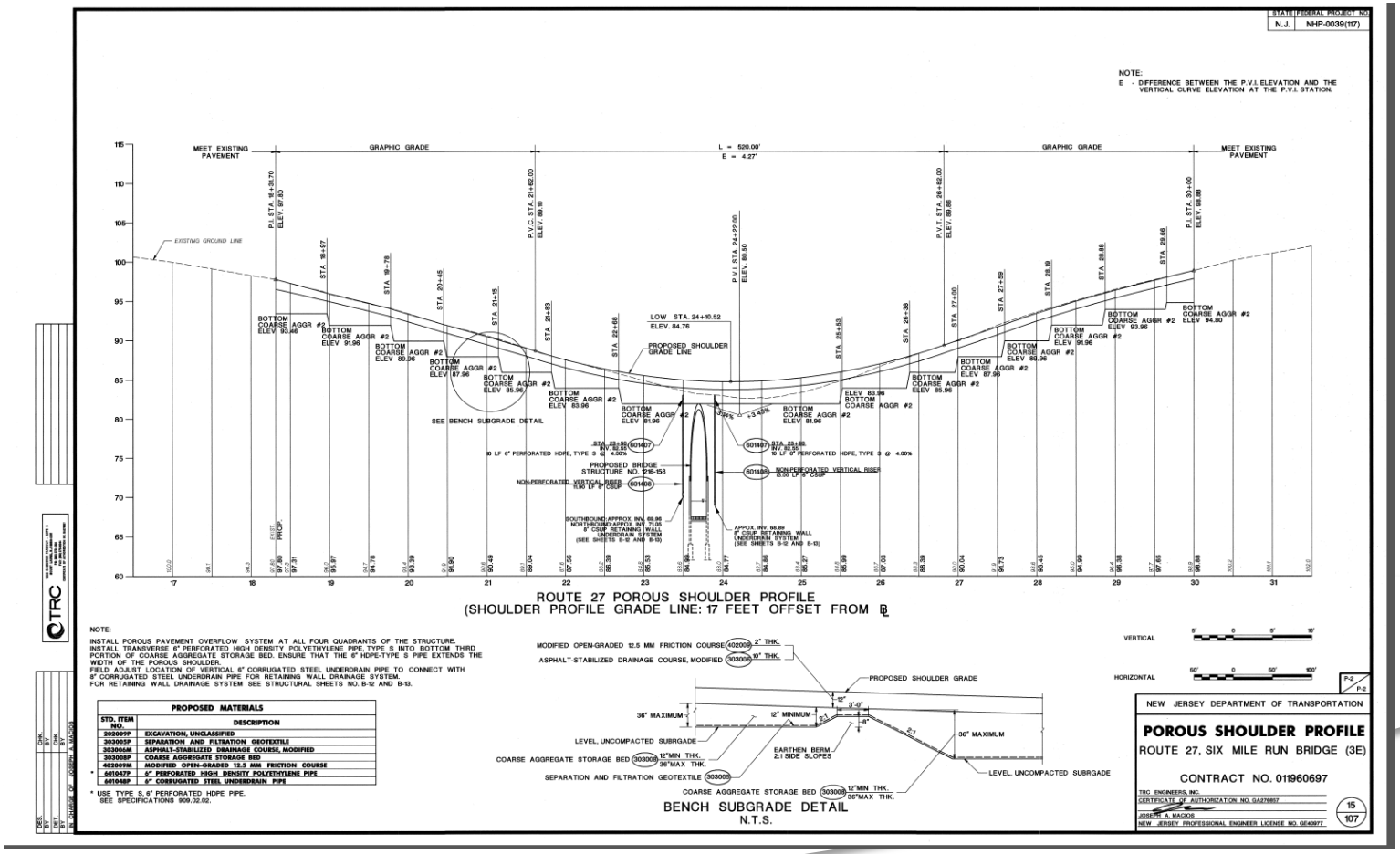
## Final Longitudinal Profile

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**Construction Notes**:

- Up to 1” thick Coarse Aggregate No. 57 was placed over Coarse Aggregate Storage Bed to stabilize the material for HMA placement
- Vibratory Roller on Storage bed; Maximum lift thickness 8”
- Asphalt Stabilized Drainage Layer was constructed in two lifts of 5” each
- Only Static roller was used on the drainage layer
- No major issues during construction
- Shoulder withstood traffic during staging without any issues
- No rutting issues till now

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**Post Construction FWD Testing:**

- To evaluate initial layer coefficients
- Testing done on 8/19/15
- Loads: 6, 9, and 12 kips
- Normalized loads: 9 kips
- Geophone settings (in.): -12, 0, 12, 18, 24, 36, 48, 60, 72

# POROUS PAVEMENT PILOT PROJECT

| | Based on FWD Testing | | | | Estimated Layer Coefficient of Total AC Layer (12") | | |
|---|---|---|---|---|---|---|---|
| | | | | | Based on Backcalculated $E_{AC}$ | | Based on $SN_{eff}$ from FWD (AASHTO 1993 Guide) |
| | $E_{AC}$ (ksi) | $SN_{eff}$ | Unadjusted $M_R$ (psi) | Seasonally Adjusted $M_R$ (psi) | MDSHA Equation (Pg. III-101, MDSHA May 2006 Pavement Design Guide) | AASHTO Nomograph (Figure 2.5, Pg. II-18, AASHTO 1993 Guide) | |
| **NB** | 397 | 8.70 | 7035 | 4562 | 0.33 | 0.42 | 0.44 |
| **SB** | 350 | 8.18 | 9070 | 5876 | 0.32 | 0.39 | 0.40 |
| **Average** | **374** | **8.44** | **8052** | **5219** | **0.32** | **0.41** | **0.42** |

- FWD results showed better results than anticipated
- Calculated layer coefficient of entire AC layer was between 0.32-0.42
- Design assumption was 0.25 = ((2*0.4+10*0.22)/12)

# POROUS PAVEMENT PILOT PROJECT

## Maintenance Plan

- Sweeping- pure vacuum type or regenerative air sweeper at least twice a year
  - Pure vacuum sweeper uses transfer broom to move material to 27-30 inch wide vacuum
  - Regenerative sweeper uses an air blast with a centrifugal dust separator
- Do not seal coat
- There shall be no repair or treatment of porous pavement surfaces with other types of pavement surfaces. All repairs to porous pavement surfaces must be accomplished utilizing porous pavement materials or infrared heating and reworking of the existing material.
- Concentrated runoff from roof drains, piping, swales or other point sources directly onto the porous pavement surface shall not be allowed. These areas must be diverted away from the porous pavement.
- The Porous pavement will be inspected **once a quarter and within 24 hours after every storm event greater than 2.0 inches.**

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## Conceptual Design Guide for Porous Pavement

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**Video**

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**Special Thanks To**:

- Robert Blight (NJDOT)
- Narinder Kohli (NJDOT)
- Dr. Roseen (UNHSW)
- Nanama Awuku (NJDOT)
- Ken Hansen (NAPA)

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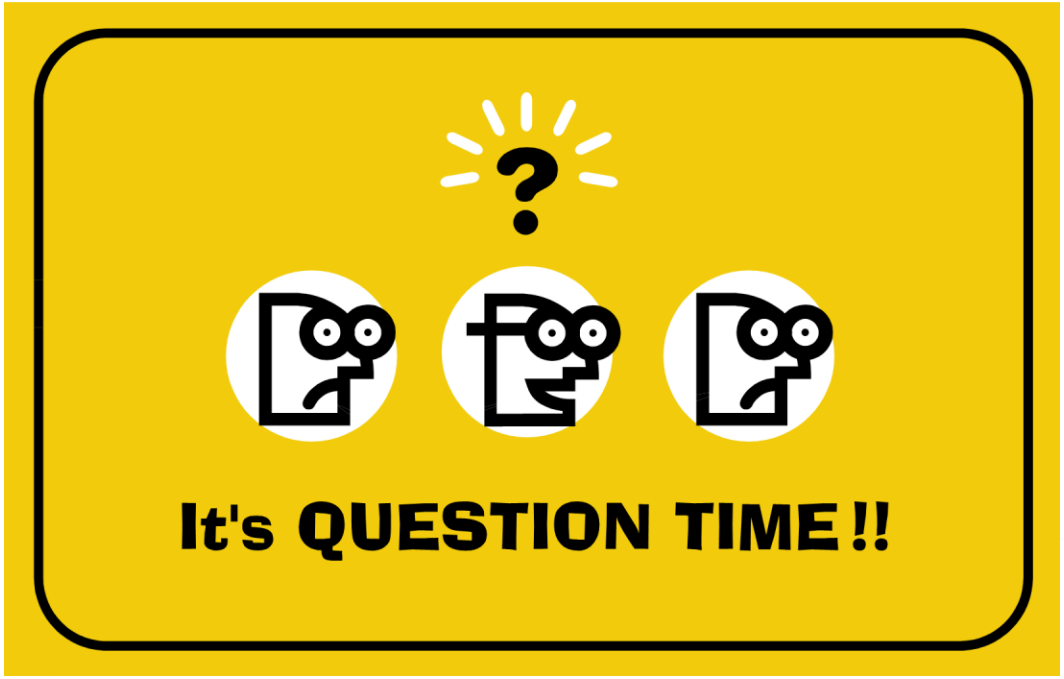


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